Aalto-yliopisto

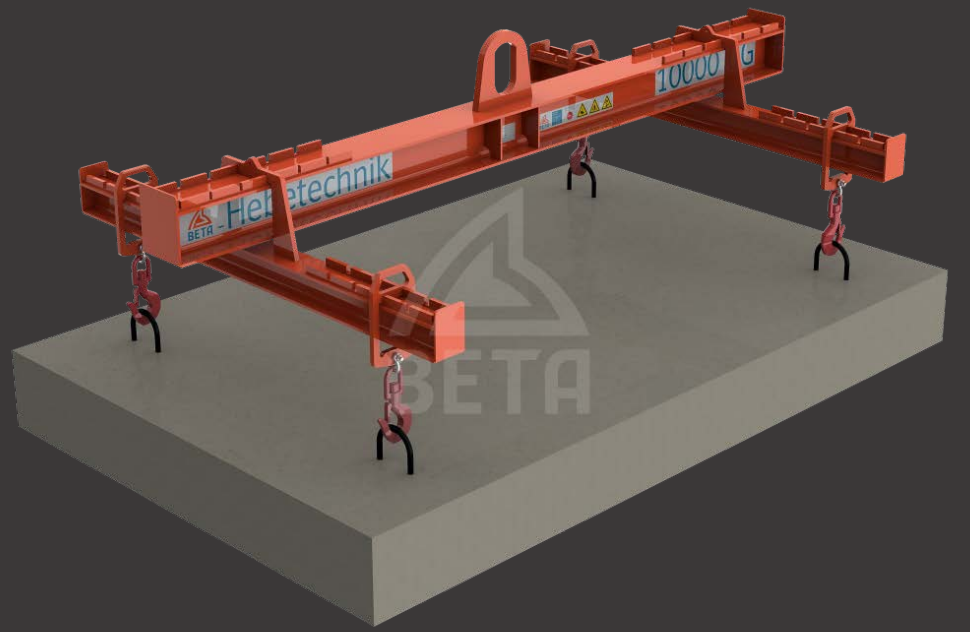
Slinging in Terrain

Self-Leveling Spreader Beam
for Adjusting the Orientation of an Overhead Crane Load

Sean Connor | Mikko Heliö | Aleksi Kuuva | Paavo Palomäki

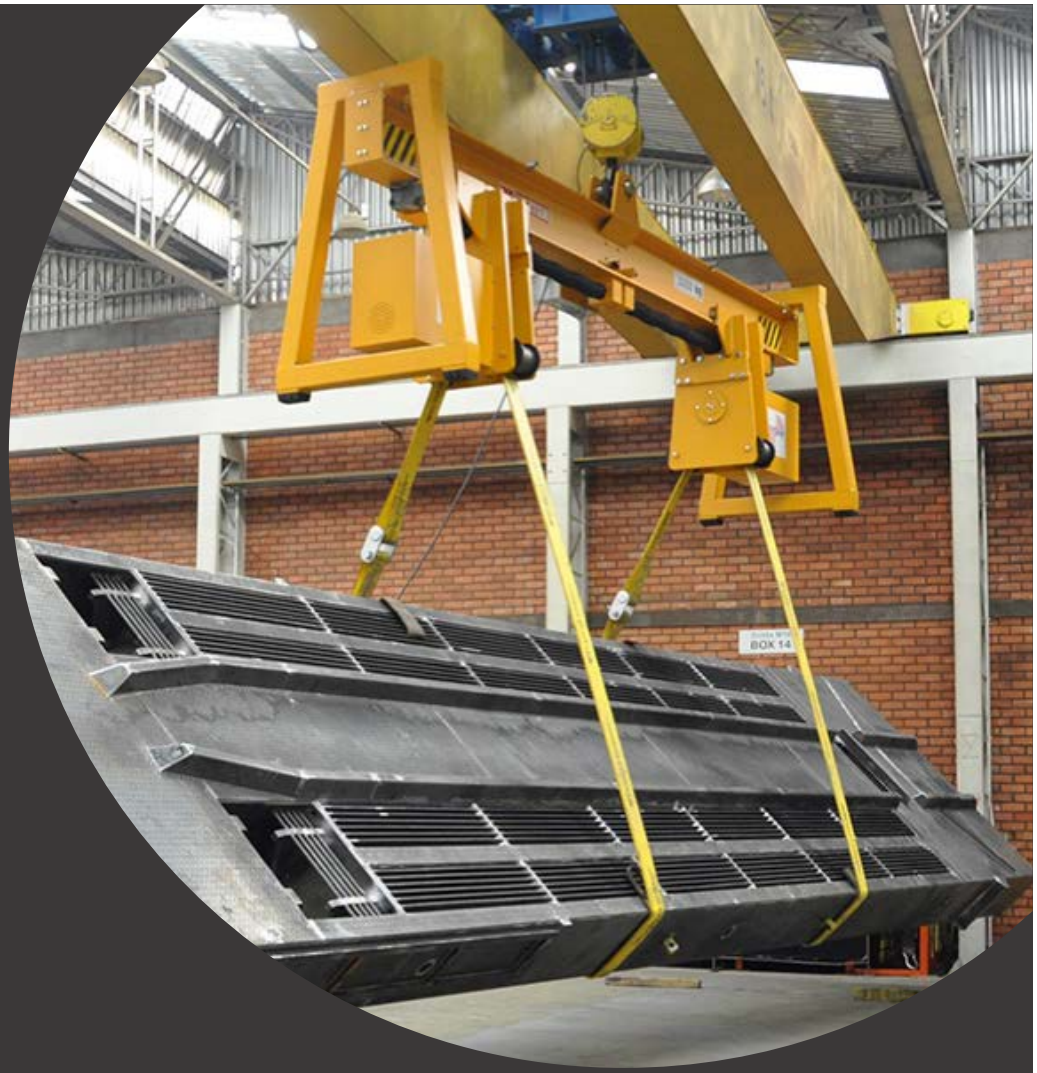
What already exists?

- H-frame



What already exists?

- H-frame
- Die Turner



What already exists?

- H-frame
- Die Turner
- Spreader Beam with fixed slings

Can something better be made?

- Reorient crane load in-air

Can something better be made?

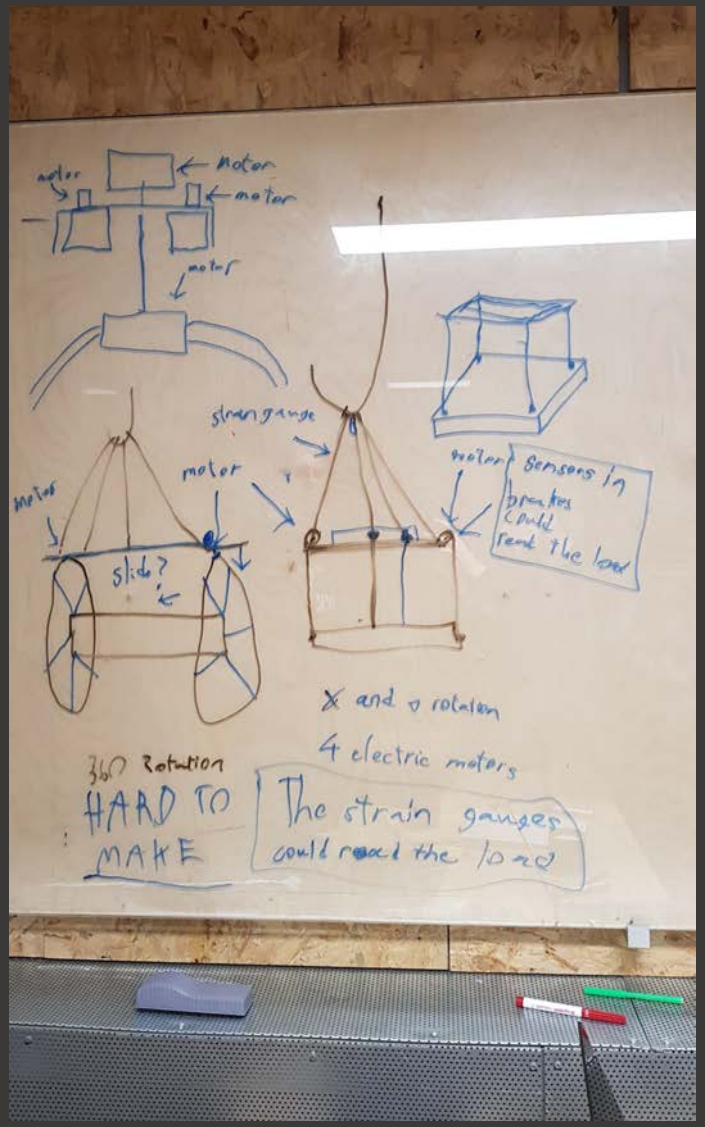
- Reorient crane load in-air
- Remote Operation

Can something better be made?

- Reorient crane load in-air
- Remote Operation
- Automatically balancing

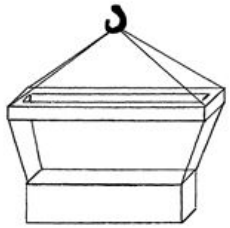
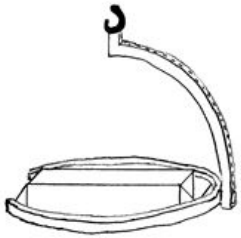
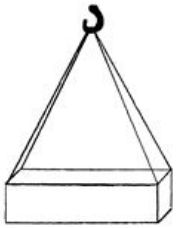
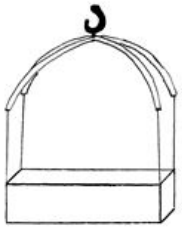
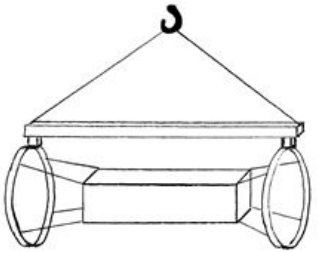
Can something better be made?

- Reorient crane load in-air
- Remote Operation
- Automatically balancing
- Easy to use

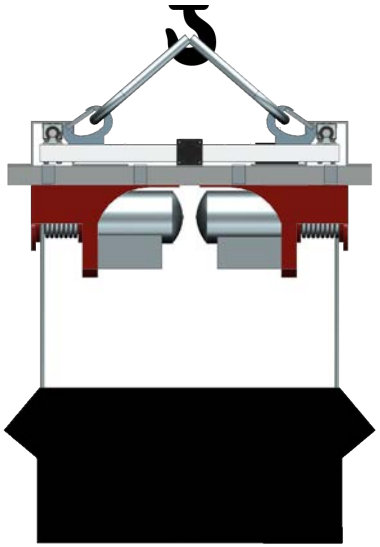

motor
motor
motor
motor
strain gauge
motor
motor
slide?
Sensors in
X and Y rotation
4 electric motors
360 Rotation
HARD TO
MAKE
The strain gauges
could read the load

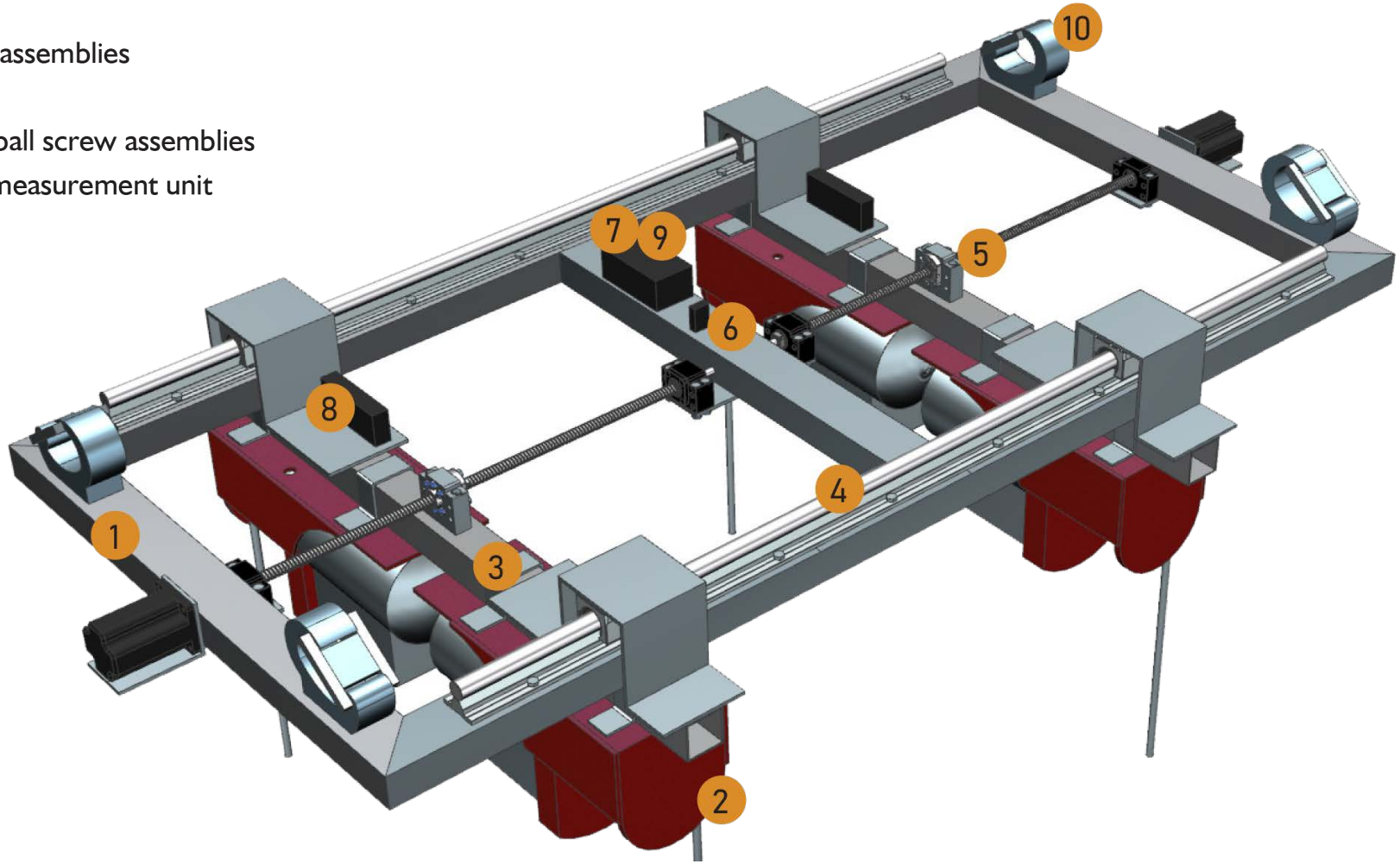
Solutions →

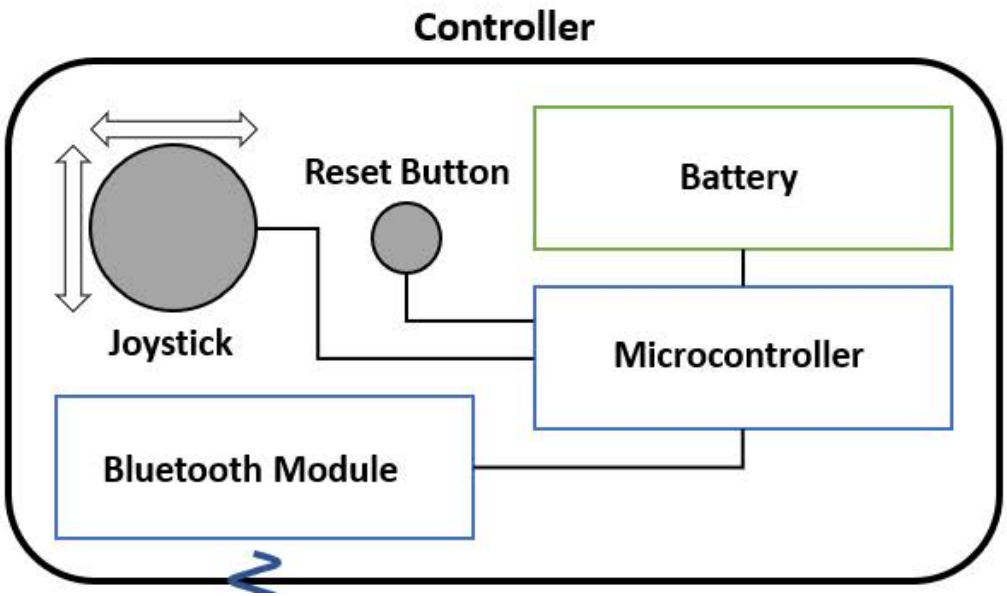
Subsystems ↓

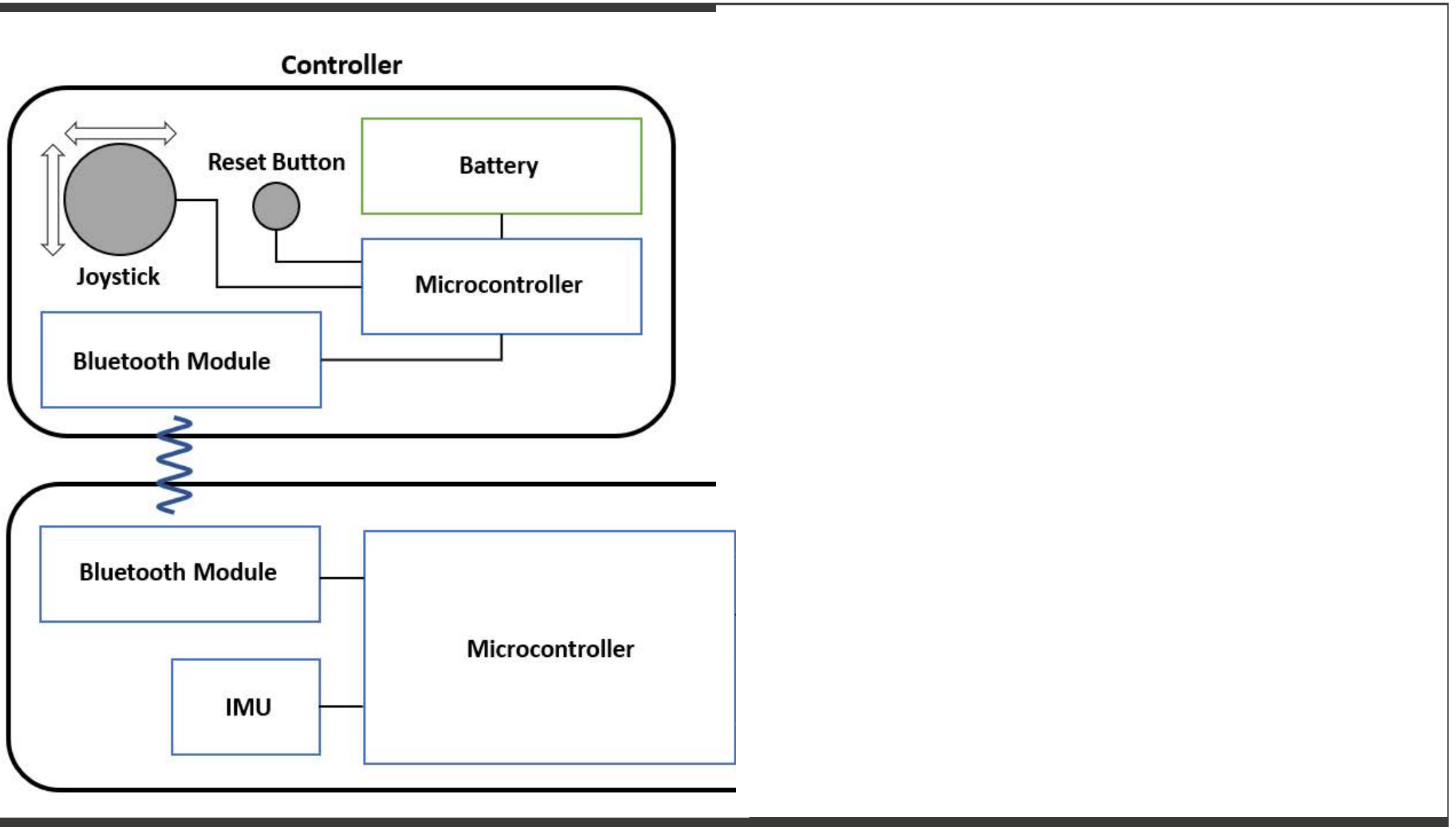
Support frame	 rectangular	 gimbal	 none	 arc-shaped	 tubular
Sling shortening method	Screw	rope drum	twisting	pulley	gear
Number of lifting slings	3 pcs	4 pcs	8 pcs		
Degrees-of-freedom	1	2	3		
Hoist method	straps	chains	strings	cables	
Orientation sensing method	sensor on load	sensor in frame	inclinometers on the slings	camera on frame	
Powering method	battery on frame	cable to crane superstructure	cable straight from wall		

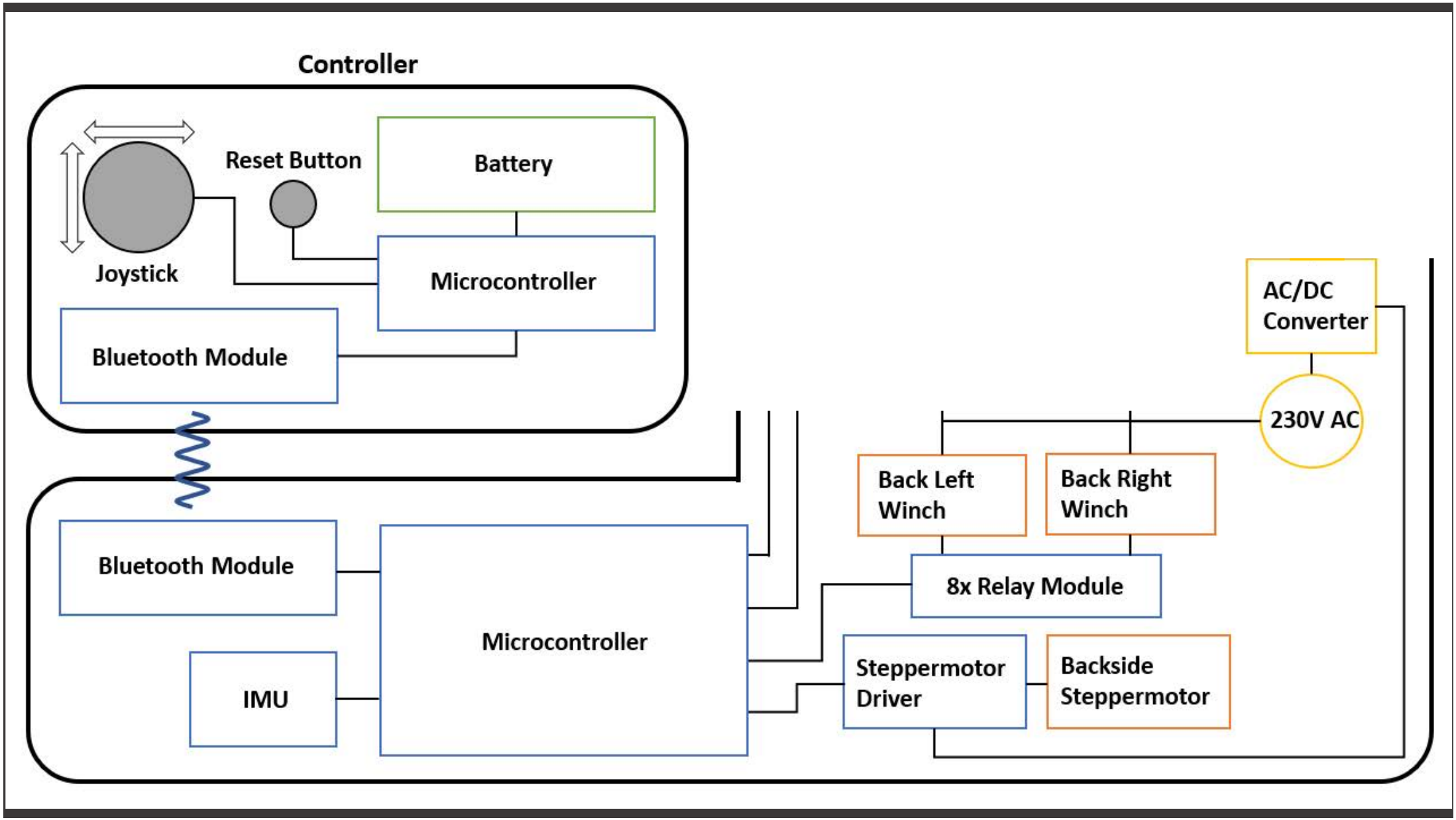
1. frame
2. 4 winches
3. 2 linearly moving trolley assemblies
4. 2 linear rails
5. 2 stepper motor driven ball screw assemblies
6. frame mounted inertial measurement unit
7. microcontroller
8. 2 relay modules
9. Bluetooth module
10. 4 hook rigging points

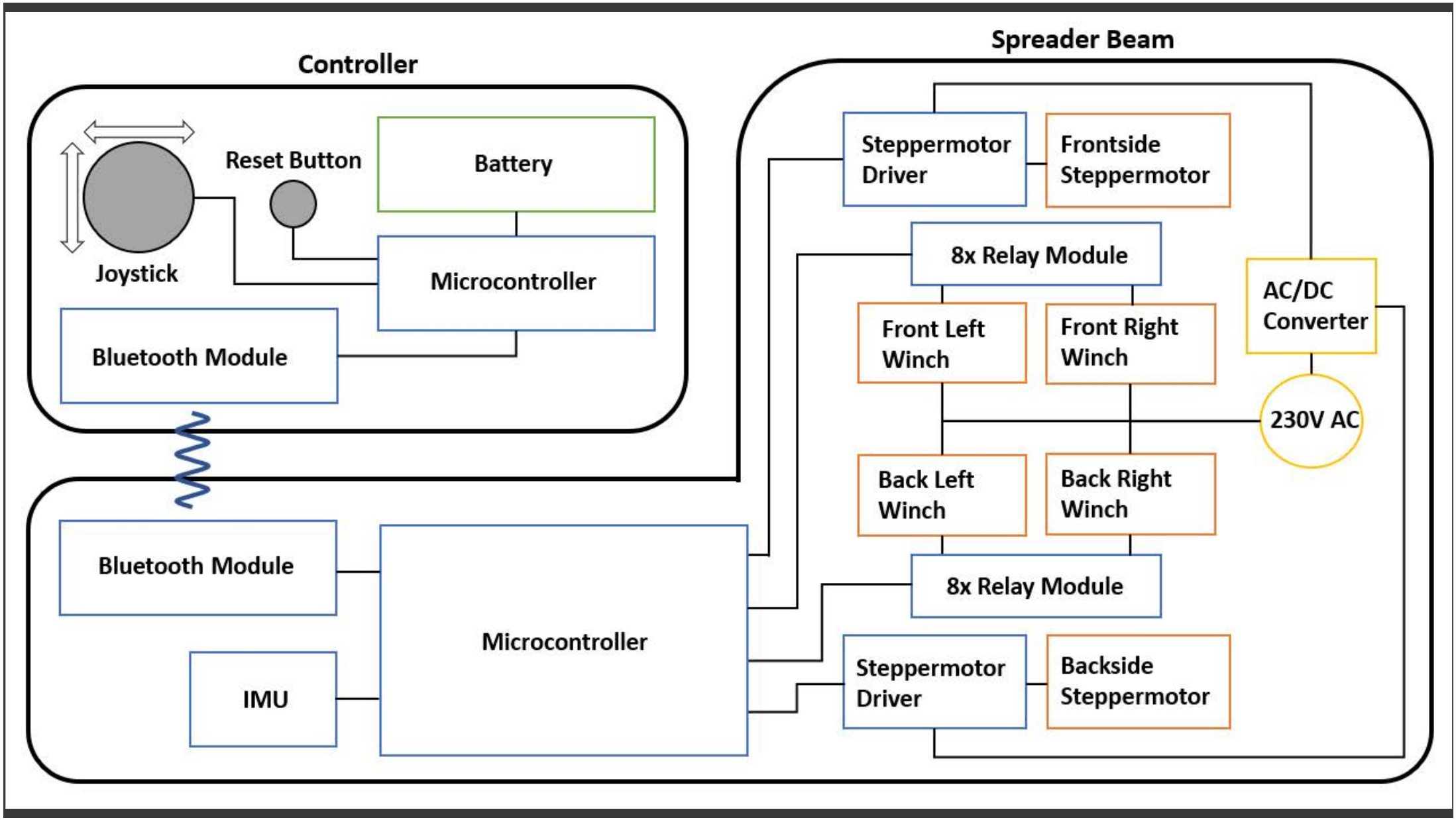




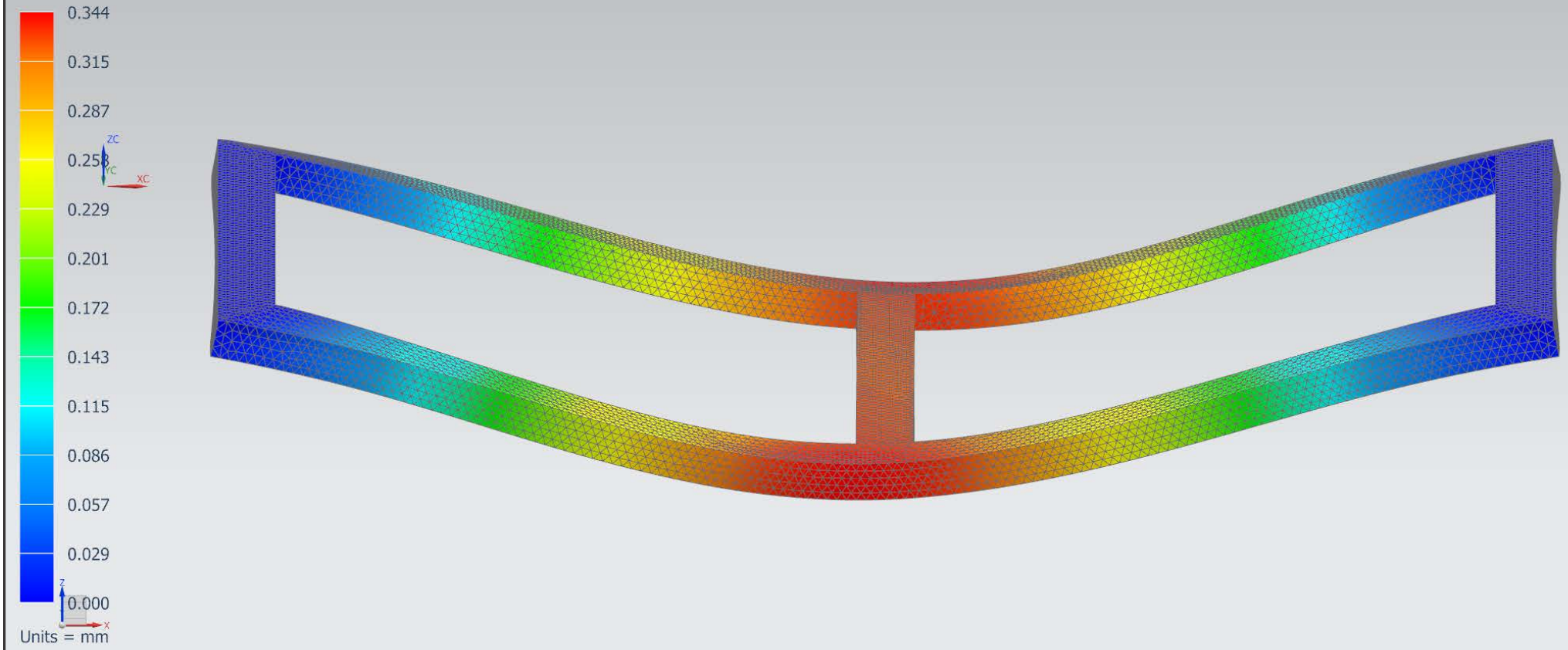

Controller
Reset Button
Battery
Joystick
Microcontroller
Bluetooth Module


Controller
Reset Button
Battery
Joystick
Microcontroller
Bluetooth Module
Bluetooth Module
Microcontroller
IMU

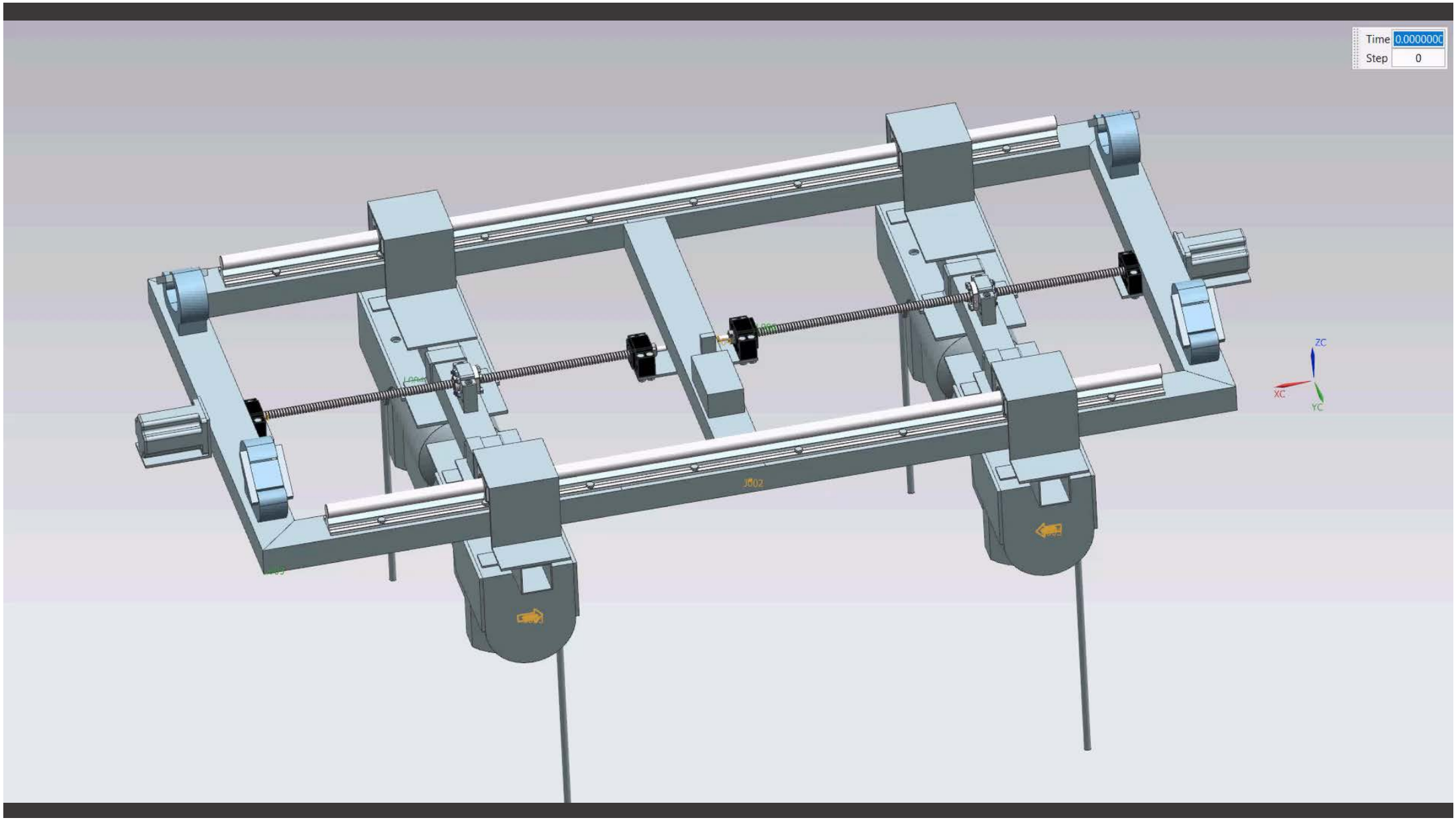

Controller
Reset Button
Battery
Joystick
Microcontroller
Bluetooth Module
AC/DC
Converter
230V AC
Back Left
Winch
Back Right
Winch
Bluetooth Module
8x Relay Module
Microcontroller
IMU
Steppermotor
Driver
Backside
Steppermotor

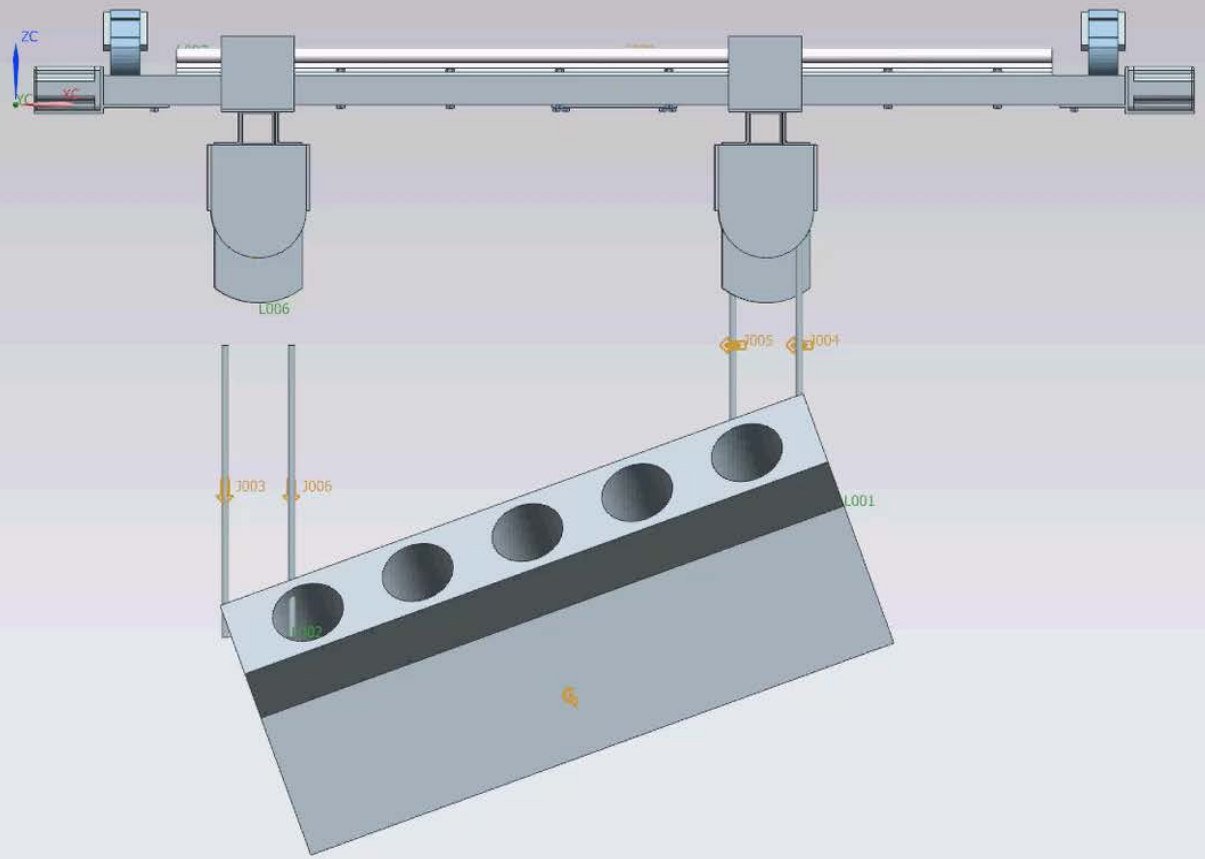

Controller
Reset Button
Battery
Joystick
Microcontroller
Bluetooth Module
Bluetooth Module
Microcontroller
IMU
Spreader Beam
Steppermotor Driver
Frontside Steppermotor
8x Relay Module
AC/DC Converter
Front Left Winch
Front Right Winch
230V AC
Back Left Winch
Back Right Winch
8x Relay Module
Steppermotor Driver
Backside Steppermotor

system2_sim2 : Solution 1 Result
Subcase - Static Loads 1, Static Step 1
Displacement - Nodal, Magnitude
Min : 0.000, Max : 0.344, Units = mm
Deformation : Displacement - Nodal Magnitude



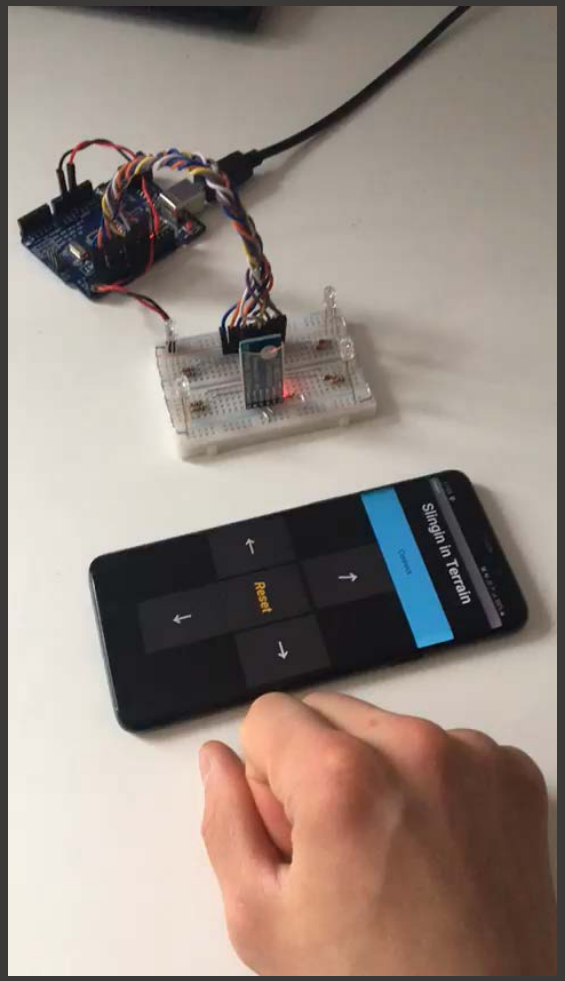
DROP FORGED
ELORA

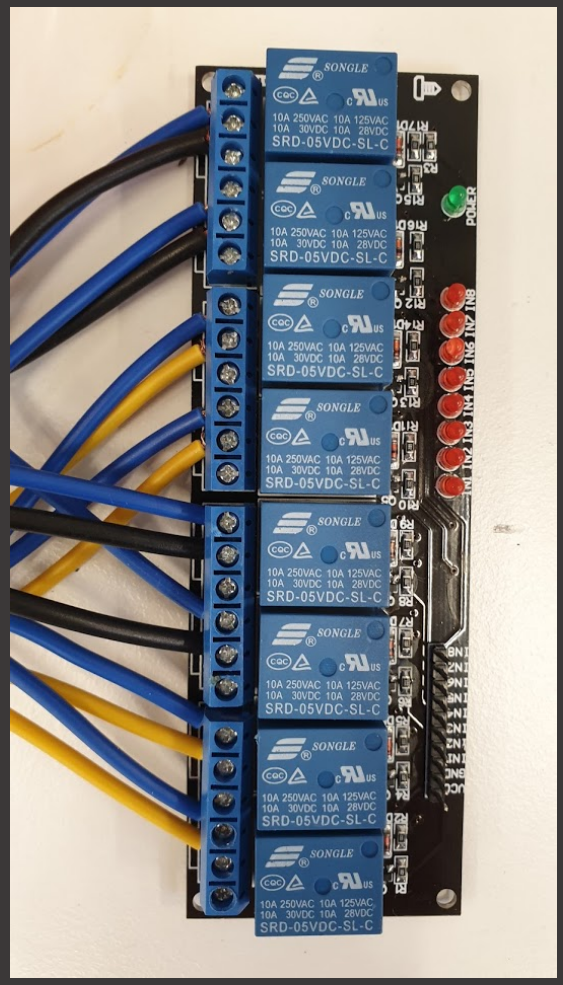

Time 0.0000000
Step 0
ZC
XC
YC



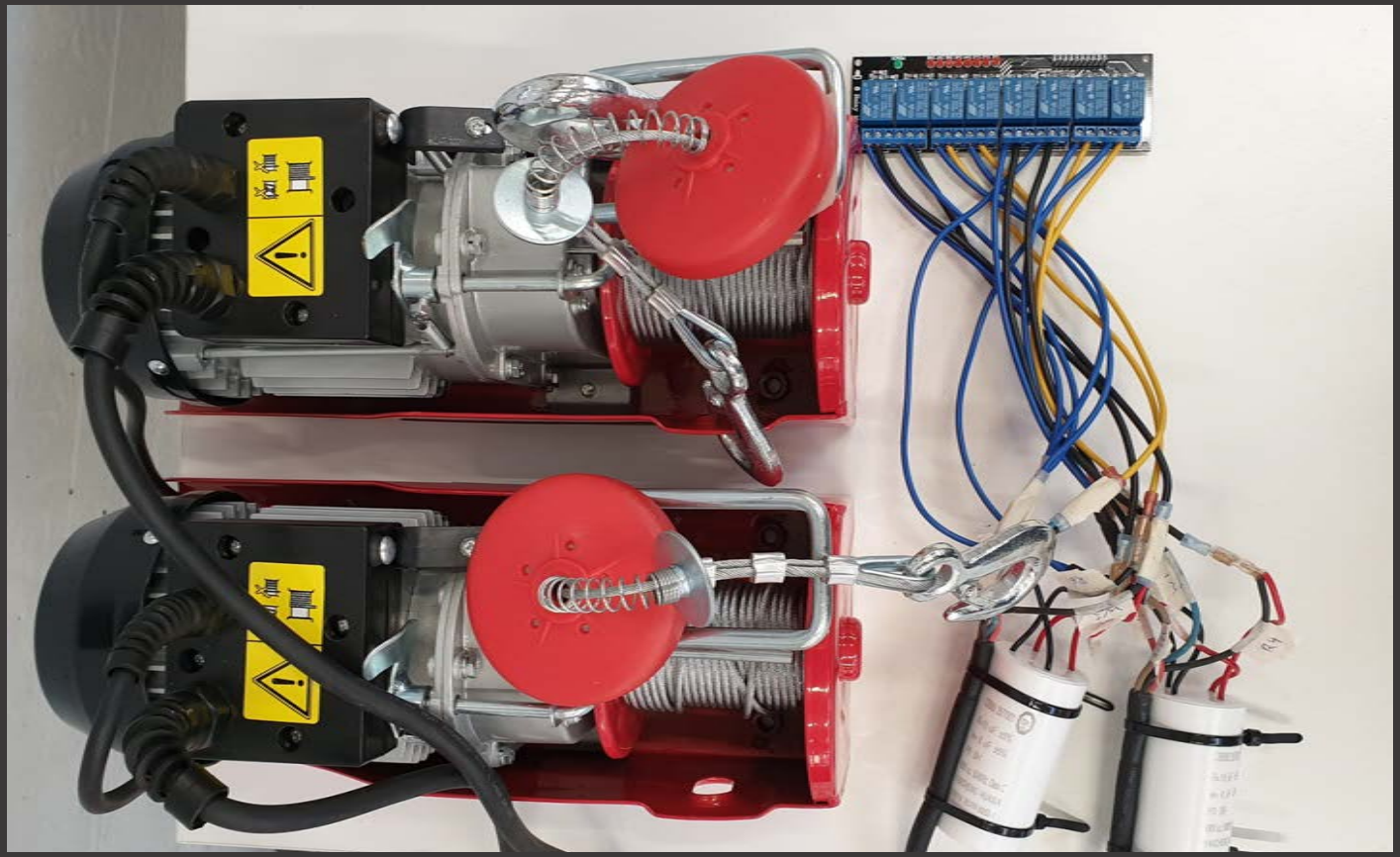
Time 10.000000
Step 100

Bluetooth Controller Proof of concept

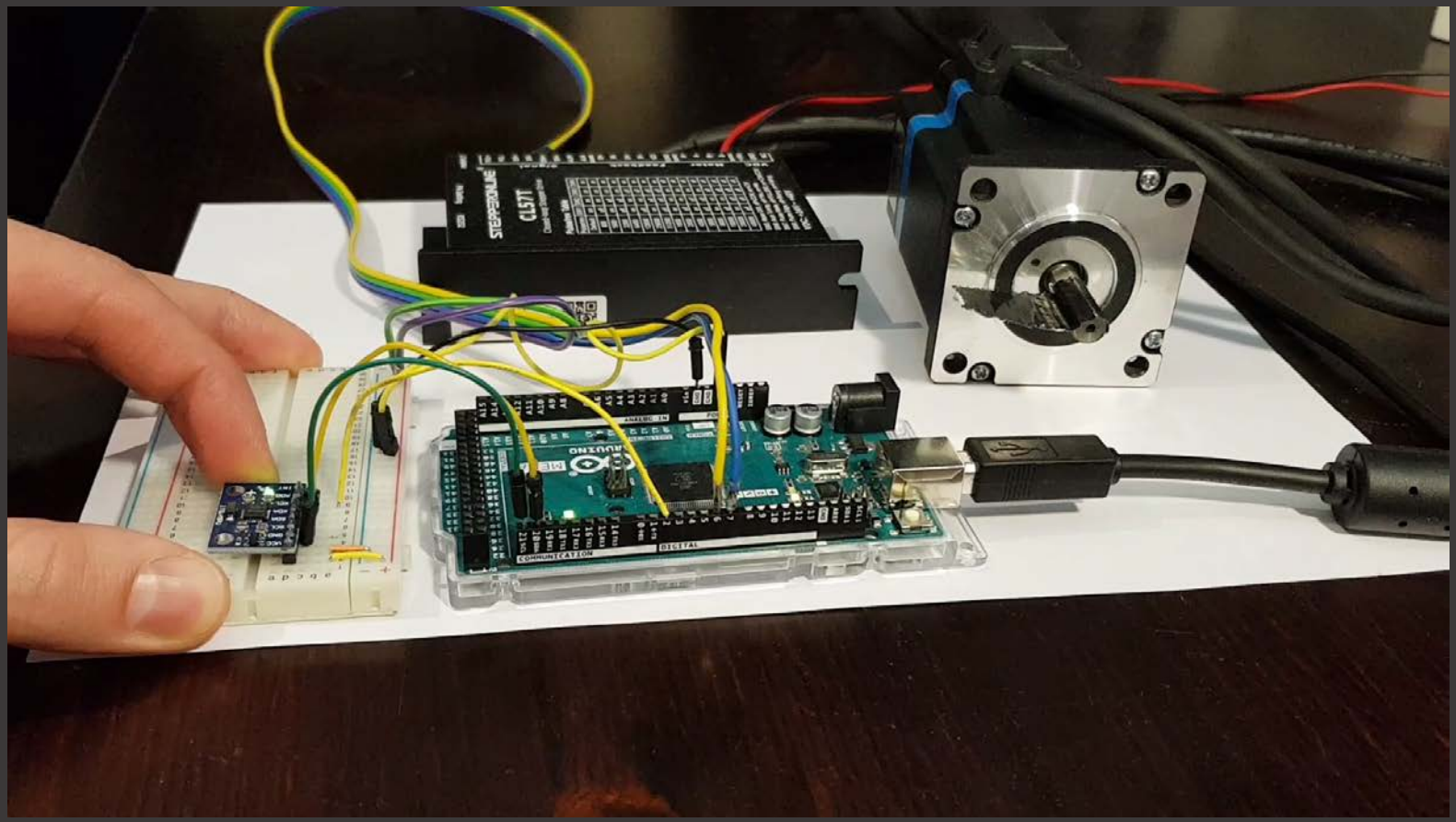




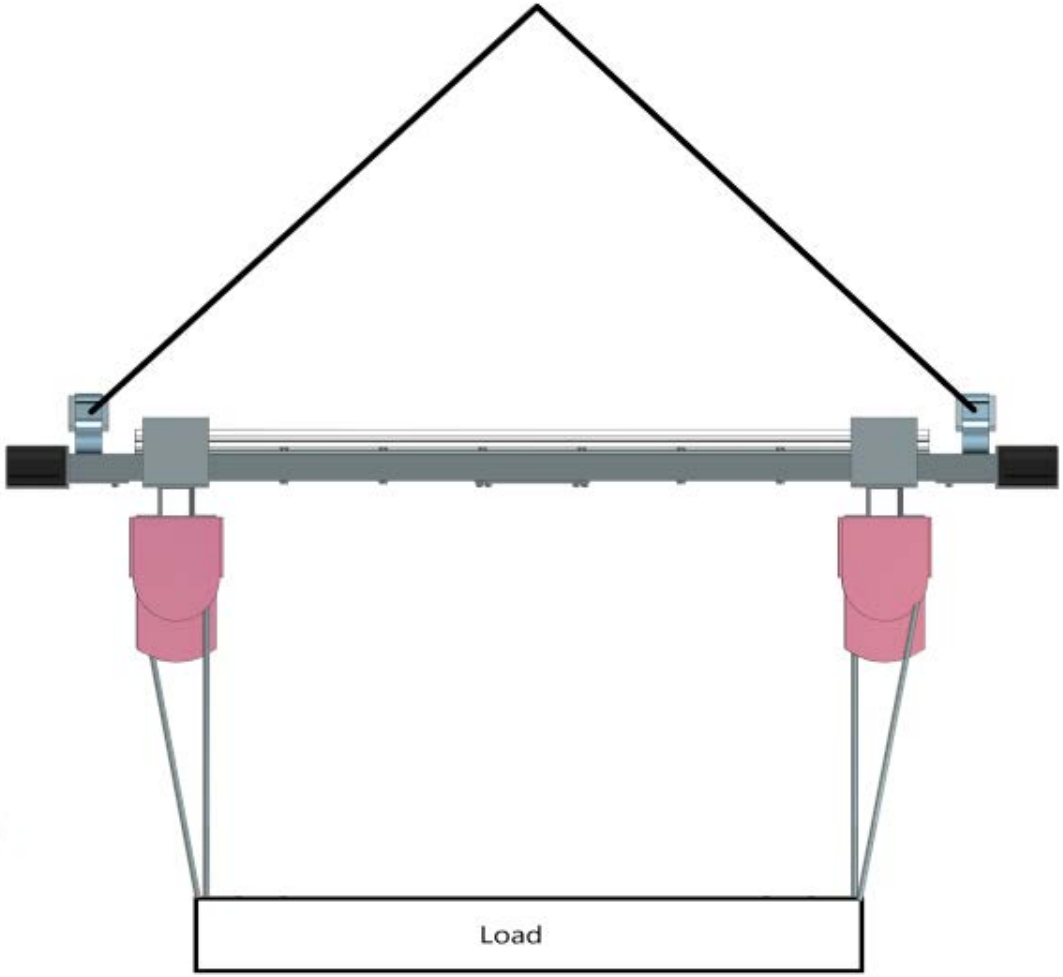
Relay modules



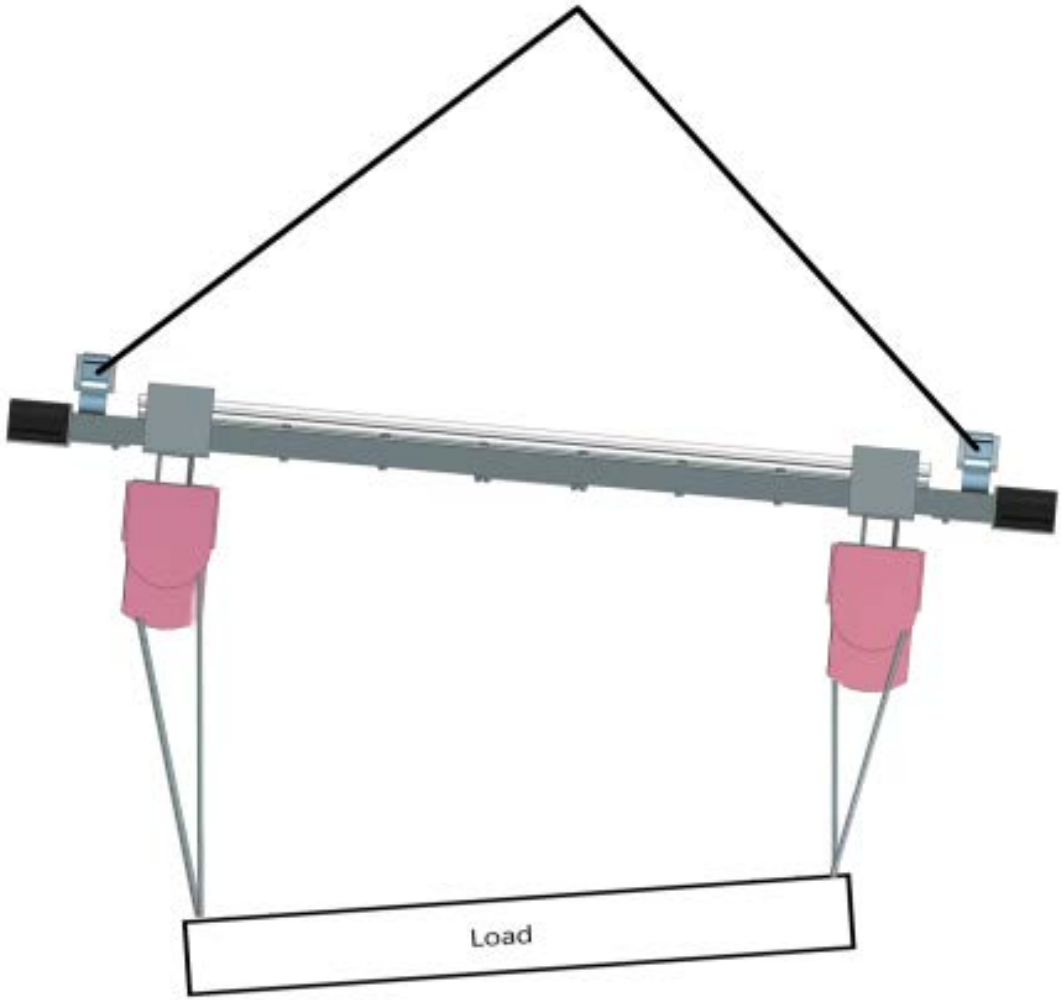
Stepper control



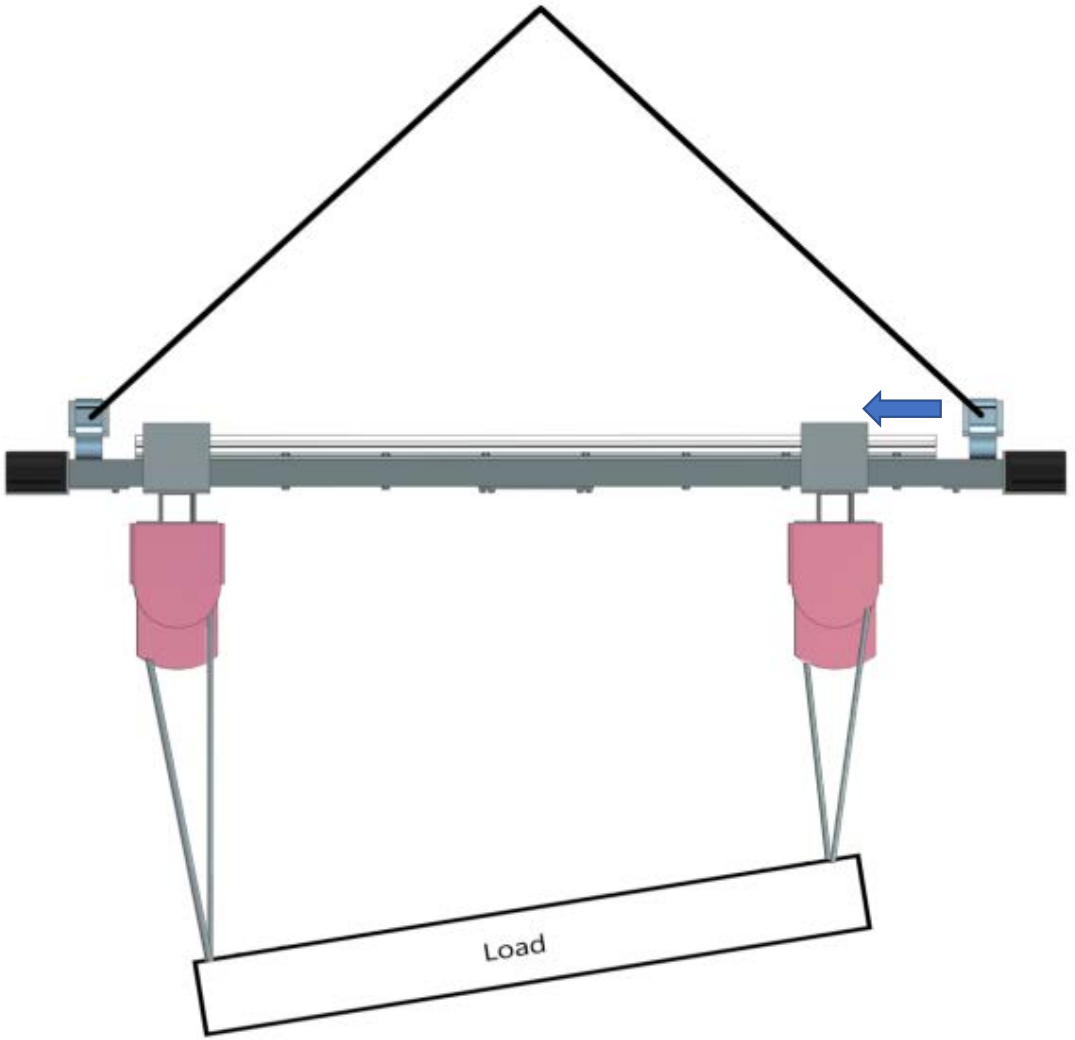
Load under frame



Load rotated



Frame balanced



Discussion

- Microcontroller capability

Discussion

- Microcontroller capability
- Potentiality to execute the task

Discussion

- Microcontroller capability
- Potentiality to execute the task
- Diversify the range of crane use

Future steps

- Perpendicular linear movement
- Closed-loop control
- Logic to take main crane into account
- Power with batteries
- Implement sensor data filtering
- Optimize component selection

Future steps

- Perpendicular linear movement
- Closed-loop control
- Logic to take main crane into account
- Power with batteries
- Implement sensor data filtering
- Optimize component selection

Questions?